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AgroCare: AI-Powered Crop Management System

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***Abstract*—Agriculture faces growing challenges due to climate change, resource limitations, and rising global demand. AgroCare is an intelligent decision-support system designed to assist farmers through real-time crop recommendations, fertilizer suggestions, disease detection, and yield prediction. Leveraging powerful APIs like Gemini, OpenWeather, and Plant.id, combined with deep learning techniques including Convolutional Neural Networks (CNNs) and Large Language Models (LLMs), the system ensures precision and personalization. The platform features a Firebase-authenticated user interface and rich data visualizations, offering actionable insights and sustainable farming practices.**

Keywords—AgroCare, crop recommendation, fertilizer suggestion, disease detection, yield prediction, Gemini API, Plant.id, OpenWeather, CNN, LLM, precision agriculture, smart farming, Firebase, Chart.js.

I. INTRODUCTION

Agriculture remains a vital sector for global food security, yet it is increasingly challenged by unpredictable weather, pest outbreaks, soil degradation, and inefficient farming practices. To address these issues, there is a growing need for intelligent, data-driven solutions that can aid farmers in making informed decisions. *AgroCare* is a comprehensive smart farming platform designed to tackle these challenges through automation, artificial intelligence, and real-time data analysis.The system provides four core functionalities—crop recommendation, fertilizer suggestion, disease detection, and yield prediction—each integrated with modern AI technologies. By utilizing robust APIs such as Gemini for language understanding, OpenWeather for real-time climate data, and Plant.id for accurate plant disease classification, AgroCare tailors its recommendations to individual farmer needs and local conditions.

The platform is built with a user-friendly front end featuring Firebase-based authentication, secure data handling, and interactive visualizations using Chart.js. Deep learning models such as Convolutional Neural Networks (CNNs) are employed for disease detection, while Large Language Models (LLMs) assist in generating context-aware recommendations. Through this fusion of machine learning and cloud services, AgroCare empowers farmers with accessible, intelligent tools to improve crop productivity, minimize resource waste, and contribute to sustainable agriculture.

II. SYSTEM ARCHITECTURE

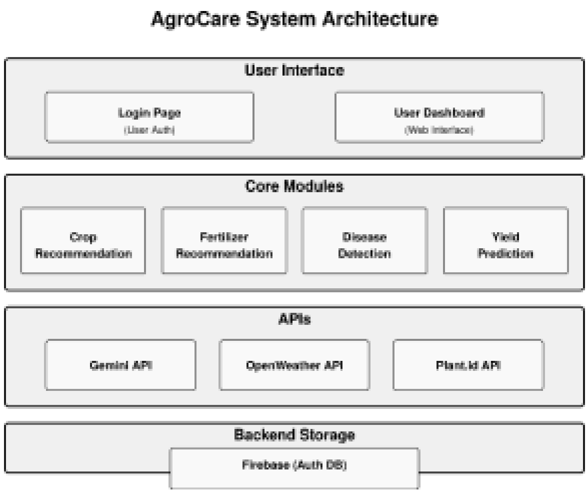

Fig. 1. System Architecture.

AgroCare is built as a modular, cloud-connected platform that integrates multiple AI models and external APIs to deliver smart agricultural recommendations. The system follows a client-server architecture, where the frontend handles user interaction, and the backend performs intelligent processing and communicates with external APIs.

A. Overall Architecture

The system architecture consists of four primary layers:

1. **User Interface Layer** – Built using HTML, CSS, and JavaScript, this layer includes a clean, responsive dashboard. Firebase Authentication ensures secure access and role-based entry.
2. **Processing Layer** – This layer handles core logic including crop recommendation, fertilizer selection, disease analysis, and yield prediction. It utilizes pre- trained ML models and APIs for real-time decision- making.
3. **API Integration Layer** – This layer enables AgroCare to interact with external services:
   - **Gemini API** is used for contextual crop and fertilizer recommendations using natural language processing.
   - **OpenWeather API** fetches location-based weather data.
   - **Plant.id API** aids in disease detection through image classification.
4. **Data Visualization Layer** – Visual insights are provided using **Chart.js**, enabling users to interpret yield trends, weather impacts, and historical performance in graphical form.

B. Module Overview

1. **Crop Recommendation Module** – Utilizes soil data, weather conditions, and user inputs, processed through Gemini and LLM models to suggest the most suitable crops.
2. **Fertilizer Recommendation Module** – Factors in crop type, soil health, and growth stage to suggest optimal fertilizers via language-based reasoning.
3. **Disease Detection Module** – Images uploaded by the user are classified using a Convolutional Neural Network and verified through the Plant.id API.
4. **Yield Prediction Module** – Trained on historical agricultural datasets and weather data to predict estimated yield using regression models or neural networks.

Each module operates semi-independently but communicates with a centralized logic controller to ensure consistency and accuracy in the recommendations. This layered and decoupled design ensures scalability, easy debugging, and future extensibility.

III. METHODOLOGY

The methodology behind the *AgroCare* system involves several interconnected components, each addressing a key aspect of agricultural decision-making. By integrating multiple technologies, we provide a comprehensive solution for crop recommendation, fertilizer suggestions, disease detection, and yield prediction.

A. Crop Recommendation using LLM

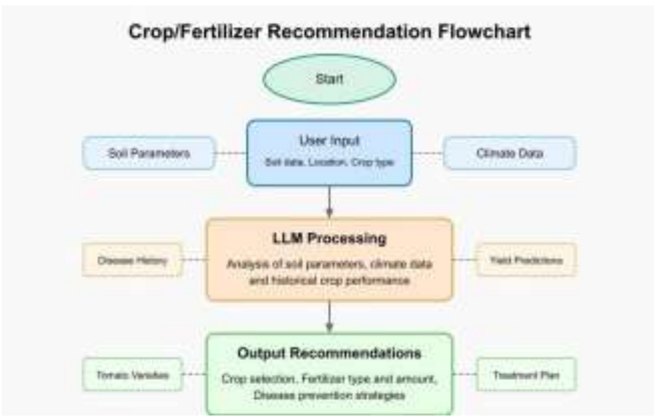

Fig. 2. Crop and Fertilizer Recommednation Flowchart.

The crop recommendation system leverages **Large Language Models (LLMs)** and natural language processing (NLP) techniques to analyze local weather data, soil conditions, and user input. The system takes inputs such as geographic location, soil type, and available resources, which are processed to recommend the most suitable crops. **Gemini API** enhances the recommendation system by understanding user queries and generating personalized suggestions based on historical agricultural data and regional climate trends.

B. Fertilizer Recommendation

Fertilizer recommendations are generated by considering various factors like soil health, crop type, and growth stage. The system calculates the optimal fertilizer composition by utilizing both historical datasets and real-time weather data from the **OpenWeather API**. The Gemini API aids in interpreting the farmer's inputs and providing the most efficient fertilizer suggestions, ensuring the crops receive the correct nutrients for healthy growth.

IV. APIs AND TECH USED

The *AgroCare* platform integrates several APIs and technologies to provide intelligent, data-driven solutions to farmers. These tools work together to enable crop recommendations, fertilizer suggestions, disease detection, and yield predictions. The following sections describe the core APIs and technologies utilized in the system.

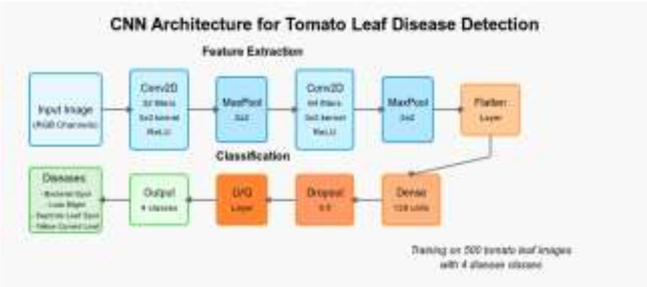

Fig. 3. CNN Arch. for Disease Detection.

Disease detection is powered by a **Convolutional Neural Network (CNN)** model trained on large datasets of plant images. The model classifies images uploaded by the user, detecting any visible symptoms of diseases. If a disease is suspected, the image is sent to the **Plant.id API**, which provides additional verification and identification. This integration helps deliver highly accurate results, ensuring

A. Gemini API

that farmers receive timely warnings and appropriate action steps.

C. Yield Prediction Model

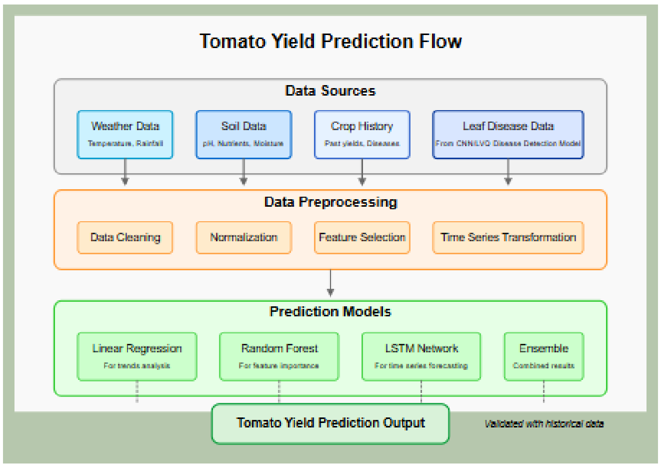

Fig. 4. Yeild Prediction Flow.

The yield prediction module relies on machine learning models trained on historical yield data, weather conditions, and crop types. A regression model or neural network predicts the potential yield for the given crop based on the inputs provided by the user. This prediction aids farmers in making informed decisions on crop management and
The **Gemini API** is used for natural language processing and contextual understanding of user queries. It helps process textual input related to crop recommendations, fertilizer suggestions, and overall agricultural advice. By leveraging the power of **Large Language Models (LLMs)**, the Gemini API ensures that the system can generate meaningful, personalized responses based on the user's specific needs, local climate, and agricultural conditions.

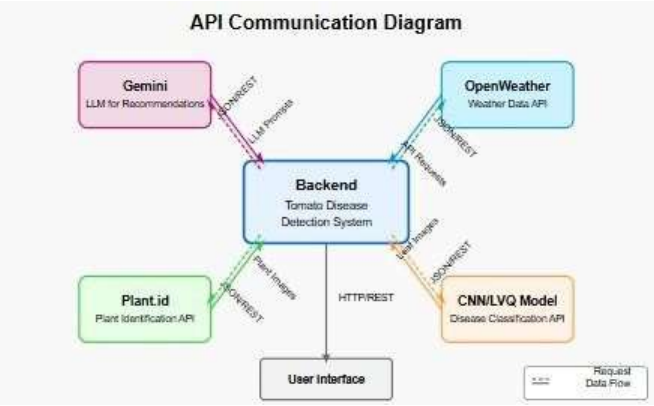

Fig. 5. API Comm. Diag.

B. OpenWeather API

The **OpenWeather API** provides real-time weather data, including temperature, humidity, precipitation, and other environmental factors. This data is critical for accurate crop recommendation and yield prediction models. By analyzing the weather patterns in the user's region, AgroCare can offer dynamic and context-aware advice on crop selection, fertilizer application, and disease prevention strategies.

C. Plant.id API

The **Plant.id API** is used for plant disease detection. The system captures images of plants and sends them to the API for classification. The API analyzes these images, identifying any diseases or pests based on a vast database of plant- related images. This integration allows AgroCare to offer farmers reliable, real-time disease detection and prevention recommendations, enhancing crop health and productivity.

D. Firebase Authentication

To ensure secure access to the platform, **Firebase Authentication** is used for user login and data management. The system provides role-based access control, allowing users to securely store and access their personalized data. Firebase helps manage user credentials, ensuring a seamless and secure authentication process for farmers and stakeholders.

E. Chart.js for Data Visualization

For visualizing agricultural data, **Chart.js** is used to create dynamic, interactive charts. These charts display key insights such as historical yield data, weather trends, and disease detection results, helping farmers better understand the impact of various factors on their crops. The use of data visualization aids in decision-making, enabling farmers to optimize their practices for higher efficiency and productivity.

V. FRONT-END DESIGN AND DATA VISUALIZATION

The user interface of *AgroCare* is built with a focus on simplicity, responsiveness, and functionality. It allows farmers and agricultural stakeholders to interact with the system effortlessly, view real-time insights, and access smart recommendations.

A. Dashboard Overview

Fig. 6. Dashboard UI.

The front-end of AgroCare is developed using **HTML**, **CSS**, and **JavaScript**, providing a clean and intuitive dashboard experience. Upon logging in through **Firebase Authentication**, users are directed to a personalized dashboard that displays modules such as:

- Crop Recommendation
- Fertilizer Advice
- Disease Detection Upload
- Yield Prediction Results

Each module is accessible through a structured menu layout. The design emphasizes usability, with minimal input fields and clear call-to-action buttons for uploading data, requesting analysis, or viewing results.

B. Use of Chart.js for Visual Analytics

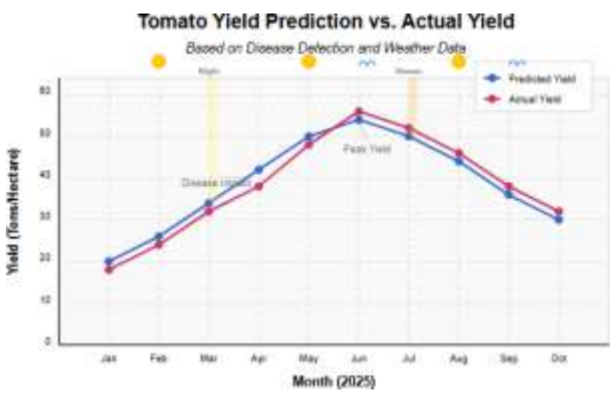

Fig. 7. Chart.js Visualization.

To enhance data interpretation, the platform uses **Chart.js**, a JavaScript library for generating responsive and interactive charts. This enables users to:

- View **historical crop yield trends**
- Compare **fertilizer effectiveness** across seasons
- Analyze **weather patterns** and their correlation with yield
- Monitor **disease occurrences** with time-based graphs

Charts such as **line graphs**, **bar charts**, and **pie charts** are dynamically rendered based on real-time data. This visual feedback allows farmers to make data-informed decisions quickly and confidently.

By integrating modern visualization tools with a user- friendly interface, AgroCare ensures that even users with limited technical expertise can benefit from AI-powered agricultural insights.

VI. CONCLUSION

AgroCare presents an integrated, intelligent agricultural assistance platform that leverages AI, APIs, and modern web technologies to support farmers in making informed decisions. By combining crop and fertilizer recommendation, disease detection, and yield prediction into a single system, AgroCare bridges the gap between traditional farming and smart agriculture.

The use of advanced tools such as Gemini API, OpenWeather API, and Plant.id ensures the system delivers reliable and context-aware suggestions. Meanwhile, the user- friendly interface and real-time visual analytics empower users to understand complex data effortlessly.

This solution not only enhances productivity and sustainability but also promotes the adoption of data-driven practices in the agricultural sector. Future enhancements may include multilingual support, voice-based interaction, and integration with IoT sensors for even more accurate and localized recommendations.

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